Analytical Hierarchy Process

(AHP)

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What is AHP ?

- According to Operations Management 4th Edition by Russell and Taylor III it is a quantitative method for ranking decision alternatives and selection the one given multiple criteria. AHP is a process for developing a numerical score to rank each decision alternative based on how well each alternative meets the decision maker's criteria.

What does it answer ?

- The question “Which one do we choose?” or “Which one is best ?” by selecting the best alternative that matches all of the decision maker’s criteria.

What does it use ?

- Simple mathematics
- criteria < set by the decision maker >
- preferences of that criteria < also set by the decision maker>
- the standard preference table

Standard Preference Table

PREFERENCE LEVEL	NUMERICAL VALUE
Equally preferred	1
Equally to moderately preferred	2
Moderately preferred	3
Moderately to strongly preferred	4
Strongly preferred	5
Strongly to very strongly preferred	6
Very strongly preferred	7
Very strongly to extremely preferred	8
Extremely preferred	9

Why not make up your own preference table ?

- Because the standard preference table has been determined by experienced researchers in AHP to be a reasonable basis for comparing two alternatives.

How is it used ?

- Say you have two criteria. Cost and quality for product A & B. The cost for A= $60 and the quality is above average. The cost for B=$15 and the quality is right at average. Which do you choose? By making a matrix the price of B is very strongly preferred to A and A is only moderately preferred to B. The matrices of these preferences would look like . . . .

Matrices of A and B

COST

	A	B
A	1	7
B	1/7	1

QUALITY

	A	B
A	1	1/3
B	3	1

- Since price B is very strongly preferred to the price of A. The score of B to B is 7 and A to B is the reciprocal or inverse of 1/7

Our sample problem

Jilley Bean Co. is selecting a new location to expand its operations. The company want to use AHP to help it decide which location to build its new plant. Jilley Bean Co. has four criteria they will base their decision on these are the following: property price, distance from suppliers, the quality of the labor pool, and the cost of labor. They have

Matrices given criteria and preferences

PRICE

	A	B	C
A	1	3	2
B	1/3	1	1/5
C	1/2	5	1

DISTANCE

	A	B	C
A	1	6	1/3
B	1/6	1	1/9
C	3	9	1

LABOR

	A	B	C
A	1	1/3	1
B	3	1	7
C	1	1/7	1

WAGES

	A	B	C
A	1	1/3	1/2
B	3	1	4
C	2	1/4	1

- Showing that in preference in price A and C are the equally preferred but are preferred over B.

How it is done ~ STEP ONE

	PRICE		
	A	B	C
A	1	3	2
	+	+	+
B	1/3	1	1/5
	+	+	+
C	1/2	5	1
	= 11/6	9	

- First sum (add up) all the values in each column.

How it is done ~ STEP TWO

	PRICE		
	A	B	C
A	1÷11/6 = 6/11	3÷9 = 3/9	2÷16/5 = 5/8
	+	+	+
B	1/3÷11/6 = 2/11	1÷9 = 9	1/5÷16/5 1/16
	+	+	+
C	1/2÷11/6 = 3/11	5÷9 = 5/9	1÷16/5 = 5/16
	= 1	1	1

- Next the values in each column are divided by the corresponding column sums.

NOTICE: the values in each column sum to 1.

How it is done ~ STEP THREE

	PRICE										
	A		B		C		Row Average				
A	6/11 ~.5455	+	3/9~.3333	+	5/8~ .6250	=	1.5038	÷3	=	.0512	
B	2/11~.1818	+	1/9~.1111	+	1/16~.0625	=	.3544	÷3	=	.1185	
C	3/11~.2727	+	5/9~.5556	+	5/16~.3803	=	1.2086	÷3	=	.3803	
										1.000	

- Next convert fractions to decimals and find the average of each row.

How it is done ~ STEP FOUR

Find the average for all the criterion by doing steps 1-3 on all the criteria. Arriving at the following

Location	Price	Distance	Labor Wages
A	.5012	.2819	.1790 .1561
B	.1185	.0598	.6850 .6196
C	.3803	.6583	.1360

How it is done ~ STEP FIVE

Rank the criteria in order of importance ~use the same method used in ranking each criterion.

Criteria	Price	Distance	Labor	Wag
Price	1	1/5	3	4
Distance	5	1	9	
Labor	1/3	1/9	1	
Wages	1/4	1/7	1/2	1

How it is done ~ STEP 6-9

- Repeat steps 1-4 with the new matrices. You should arrive at the following :

Criteria	Price	Distance	Labor	Wage	Row Average
Price	.1519	.1375	.2222	.2857	.1933
Distance	.7595	.6878	.6667	.5000	.6535
Labor	.0506	.0764	.0741	.1429	.0860
Wage	.0380	.0983	.0370	.0714	.0612

Row average= preference vector for the criteria

	CRITERIA
Price	.1993
Distance	.6535
Labor	.0860
Wage	.0612

- Clearly the price of the land is #1, followed by distance to suppliers, labor pool quality, and last cost of wages.

FINAL CALCULATIONS

Take the criteria matrix and multiple it by the preference vector

Location	Price	Distance	Labor	Wages
A	.5012	.2819	.1790	.1561
B	.1185	.0598	.6850	.6196
C	.3803	.6583	.1360	.2243

X

	C
Price	.1993
Distance	.6535
Labor	.0860
Wage	.0612

Location A score = .1993(.0512) + .6535(.2819) + .0860(.1790) +.0621(.1561) = .3091

Location B score = .1993(.1185) + .6535(.0598) + .0860(.6850) + .0612(.6196) = .1595

Location C score = .1993(.3803) + .6535(.6583) + .0860(.1360) + .

And the results are . . .

LOCATION	Score
A	.
3091	
B	.1595
C	.
5314	

Based on the scored Location C should be chosen for Jilley Bean Co. to built a plant.

1.0000

How is AHP is used in real life ?

- Expert Choice a company that specializes in AHP design software and performs services with it. Some of their clientele are:
- Ford Motor Company
- Sprint PCS
- Department of Agriculture (USDA)
- Navy
- National Health Service of the United Kingdom
- Ferrari SpA in Italy

How is AHP is used in real life ?

- The USDA used it for the selection of bridge materials across the nation in several states.

Is there anything AHP cannot be used for ?

- Not really as long as the decision maker has set criteria and set preferences of that criteria AHP can be used.

References

- Russell, Roberta S. and Taylor III, Bernard W. Operations Management 4th edition. Upper Saddle river, New Jersey: Prentice Hall, 2003.
- Expert Choice Client List <http://expert choice.com/customers/client list.htm
- Smith, Bush and Schmoldt. The Selection of Bridge Materials Utilizing the Analytical Hierarchy Process. 5 March 2003. <http://www/srs4702.forprod.vt.edu/pubsubj/abstract/ab9760.